Wavelet based Compression of Segmented Images using Baseline Non-segmented Approach

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Why segmented images?

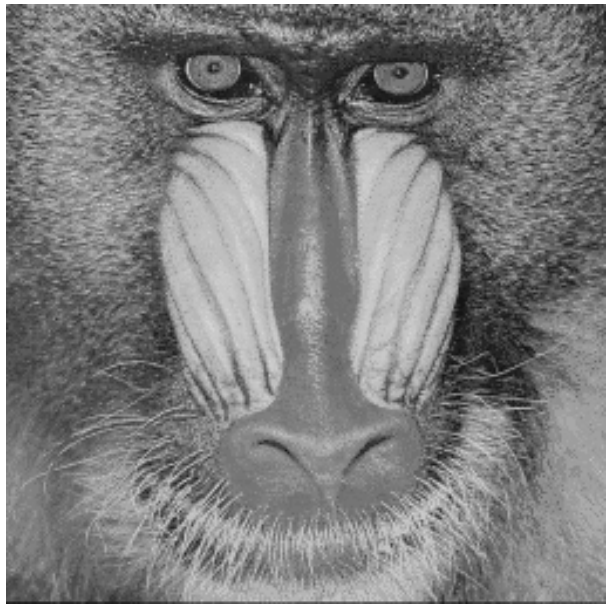
- Better adaptation to local image characteristics when coding textures in image segments
- Separate handling of image objects represented by image segments

Main goal

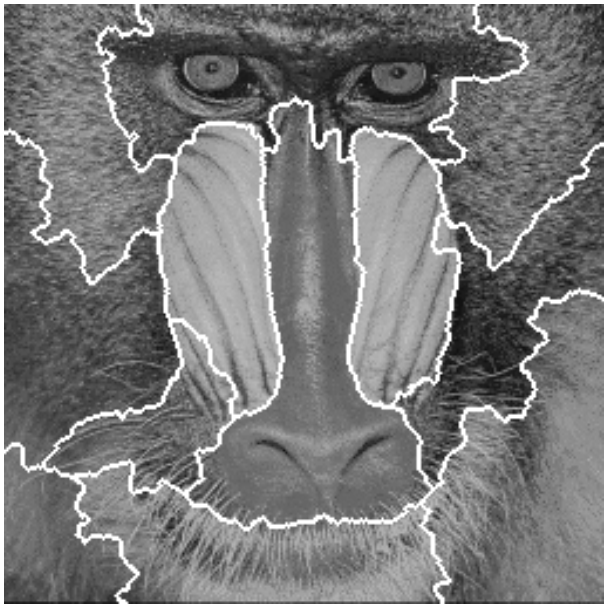
- Effective compression of segmented images using wavelet transform
- Joined coding of image segments to achieve higher compression results

Steps in coding process:

- Segmentation of an image
- Polygonal approximation of segment boundaries (improves boundary coding efficiency)
- Texture approximation/coding in segments using **Baseline algorithm with Non-segmented Approach**



Sample input image
(Baboon)



Segmented into
12 segments

Map of polygonal
approximations
for 12 segments

Unsupervised segmentation method for colour –texture regions used in [1].

a) *finding boundaries: 8-directional algorithm based on LML (left-most-looking) rule*
b) *approximating boundaries with polygons*

Baboon's polygonal maps for 30 and 5 segments

"Lena" image, 11 segments and corresponding polygonal map

Our choice for segment texture approximation/coding:

2D DWT + **Baseline algorithm with Non-segmented Approach**

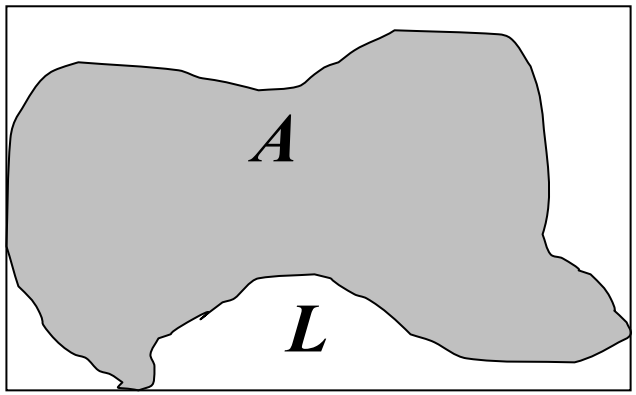
Properties

- For each segment A is performed 2D DWT on rectangle **L** circumscribing the segment **A**
- We use modified BASELINE algorithm for joined coding of spectrum for all image segments

Compared to

- SPIHT algorithm with separate coding of texture for each image segment

***For each segment* A *is performed 2D DWT on rectangle* L *circumscribing the segment* A**



How to perform the transform on rectangle ***L*** with possibly best approximation properties for segment ***A*** ?

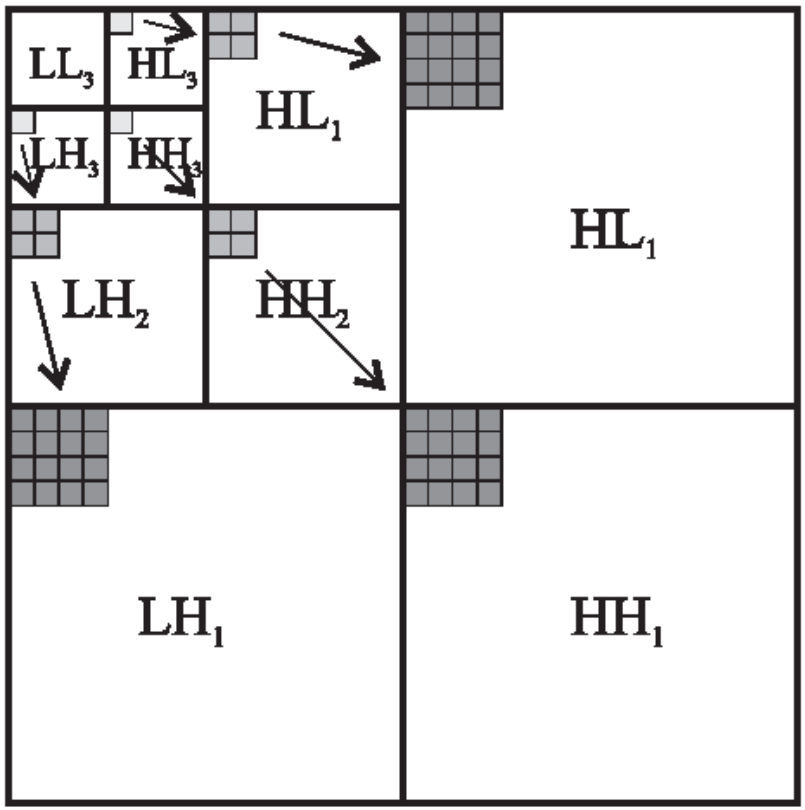
➔ More solutions proposed (mostly based on iterative approach)

- Iterative optimization of representation inside of the segment
- Texture extrapolation outside of the segment

➔ Simplest solution - extrapolate the image outside of segment A using mean value inside of the segment (only about 1% worse in sense of MSE than complex iterative approaches)

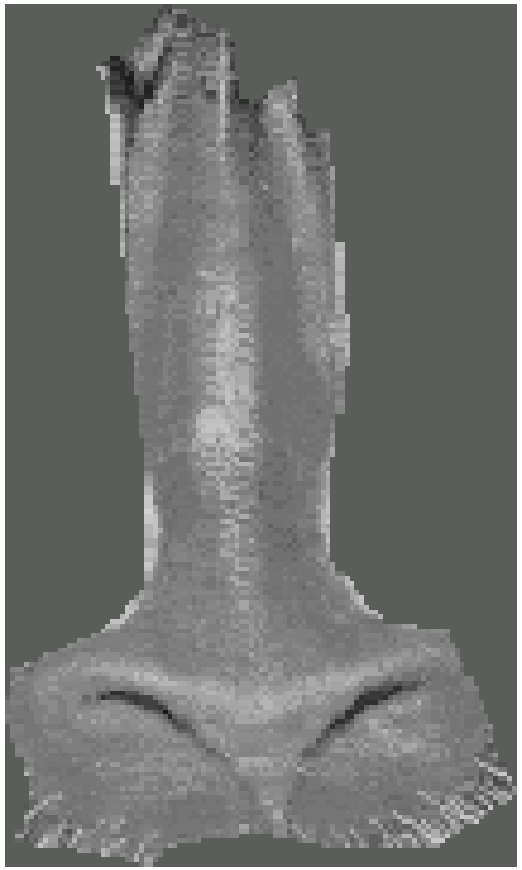
➔ In this approach we used the simplest solution.

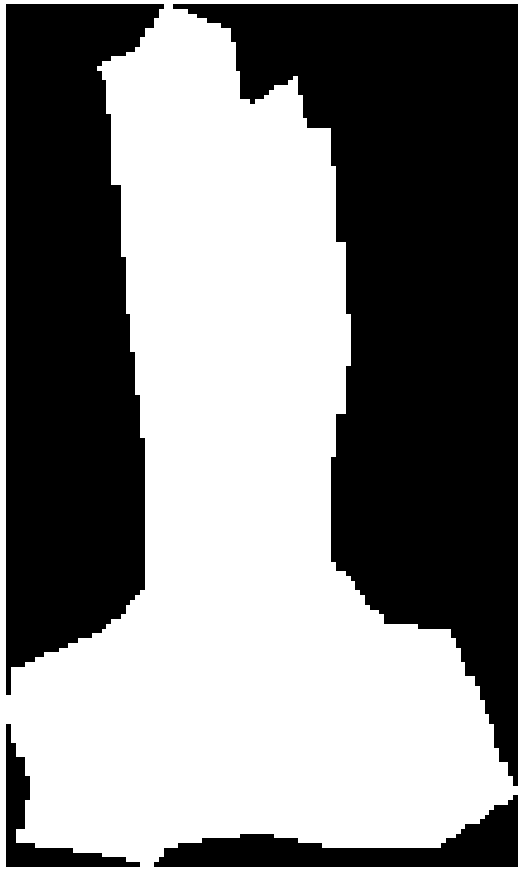
Input for coding process - structure of 2D wavelet spectrum of each segment

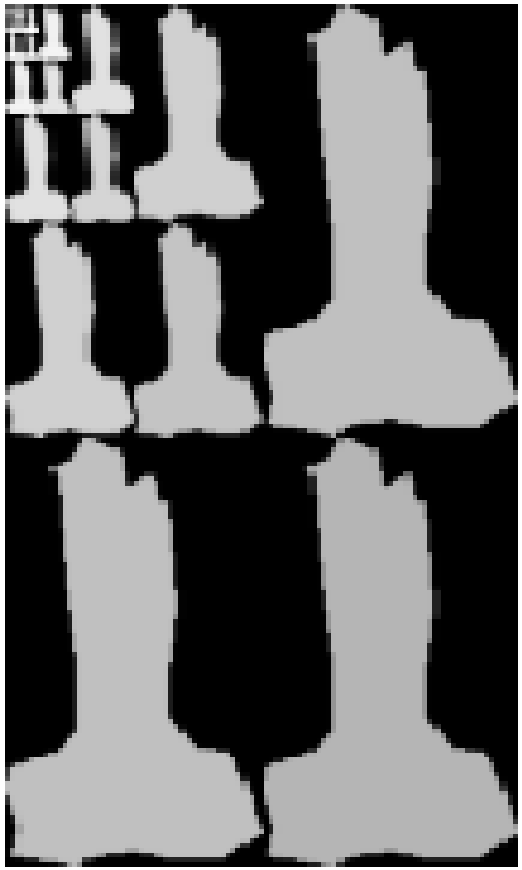


Important: magnitude hierarchical dependencies in wavelet spectrum

Obtaining valid spectral coefficients for each image segment







Segment “Baboon’s nose” time validity mask” spectral validity mask

Obtaining spectral segment validity mask

a) subsampling of segment time validity mask (PV mask)

b) "Special" wavelet transform of time validity mask using filter coefficients set to their absolute values (ET mask)

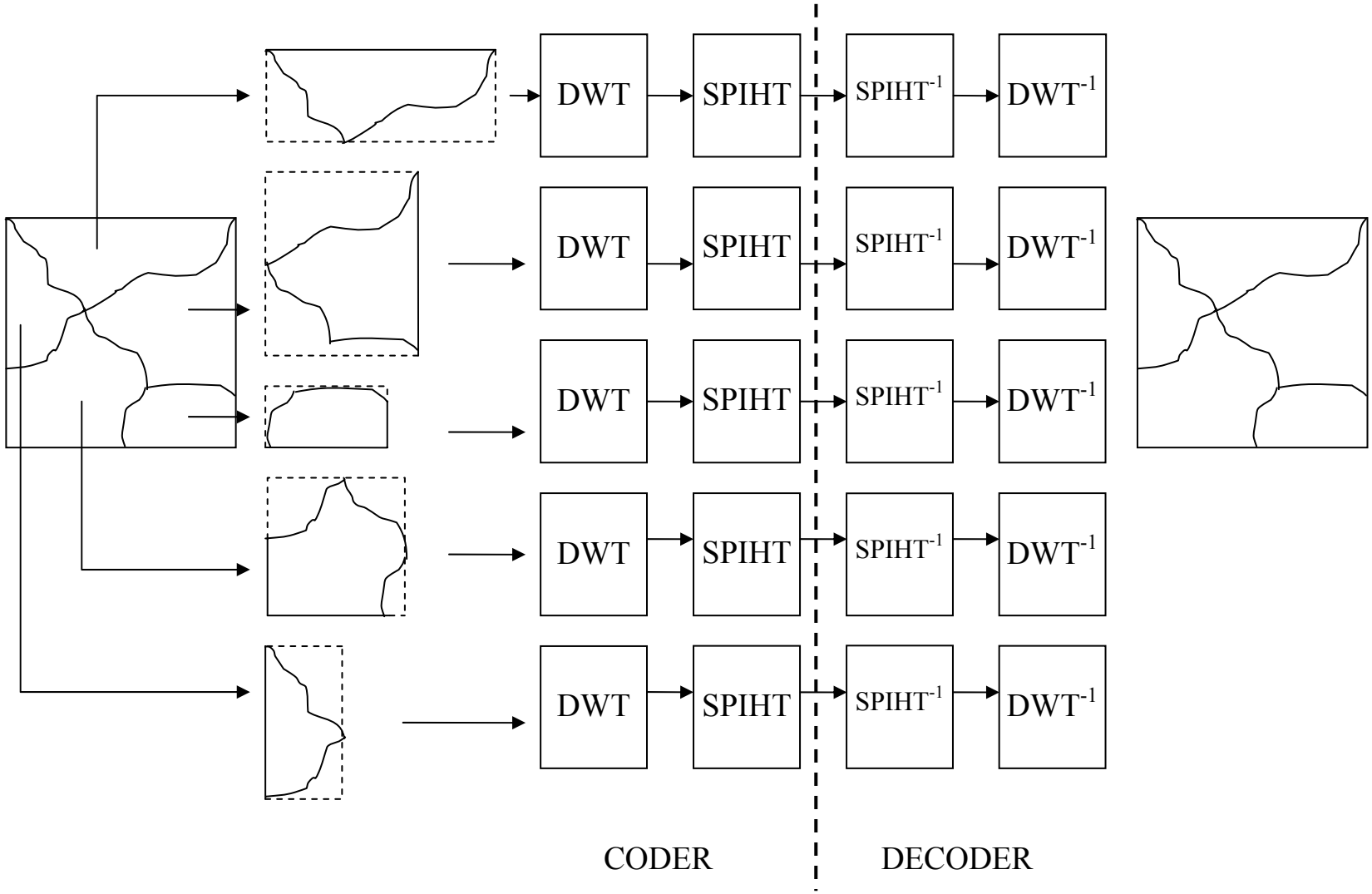
➔ Both approaches give approximately the same results
(**a** maybe a little bit better)

➔ We used the approach (**a**) which is also faster

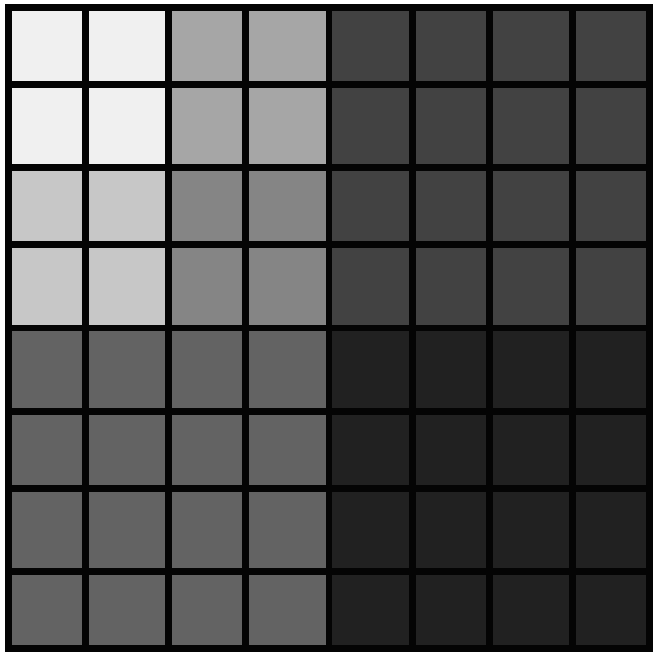
Working with segment validity mask

- SPIHT - finds zero trees only in areas selected by mask
- BASELINE - reads out only spectral values selected by mask and processes them together according to actual decomposition level

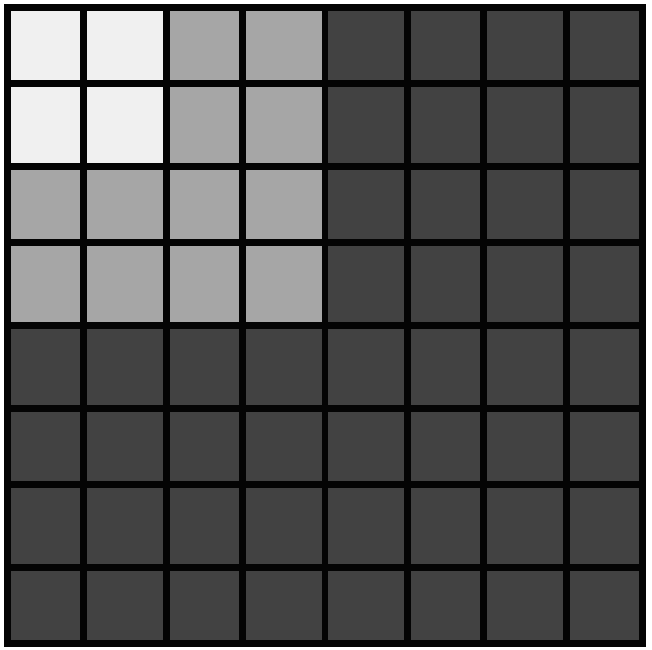
Usage of SPIHT algorithm for separate coding of texture for each image segment (SPIHT_S)



Remarks on baseline coder for non segmented images



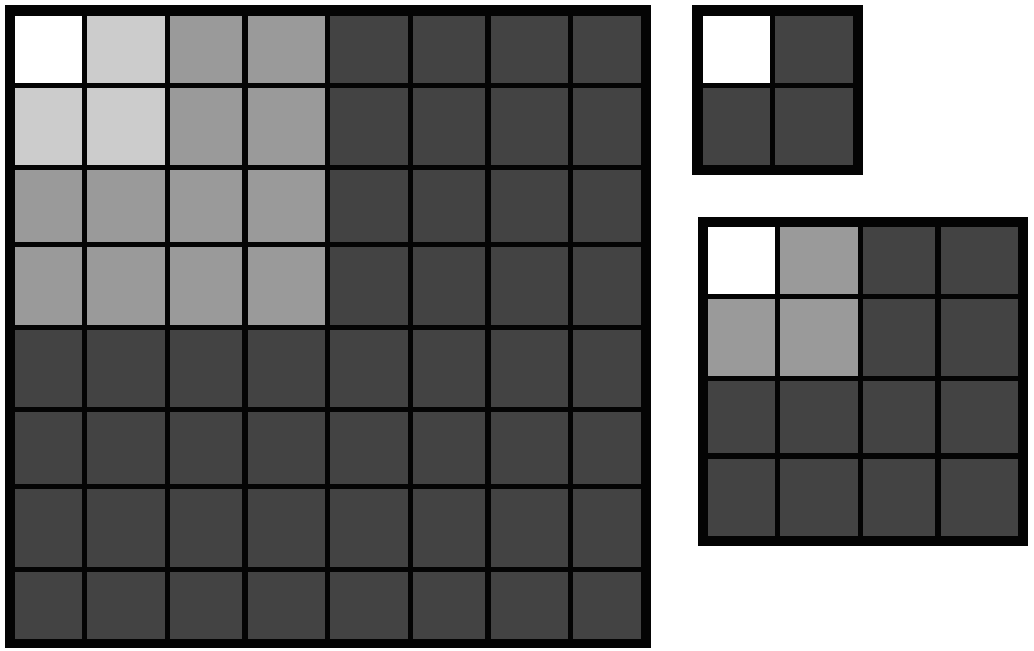
a) More quantizers (original)



b) Less quantizers(our approach)

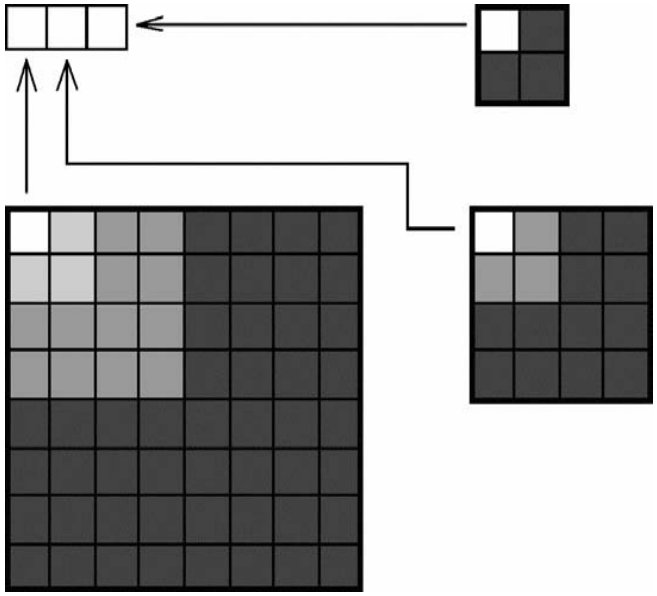
- coefficients in shaded parts of spectrum have approximately the same dynamics, they are quantized and entropically coded

How to join the spectrums of many segments to use it with BASELINE approach (ModBC) ?

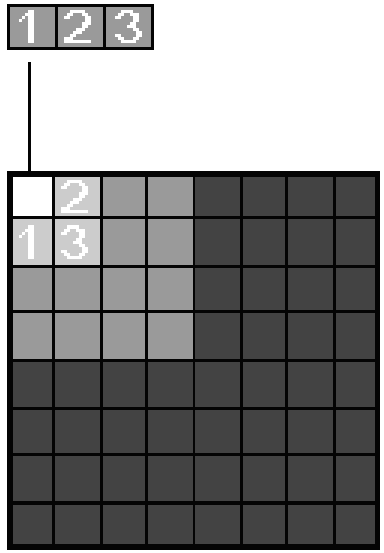


Example of 3 segments with sizes 8x8, 4x4 and 2x2

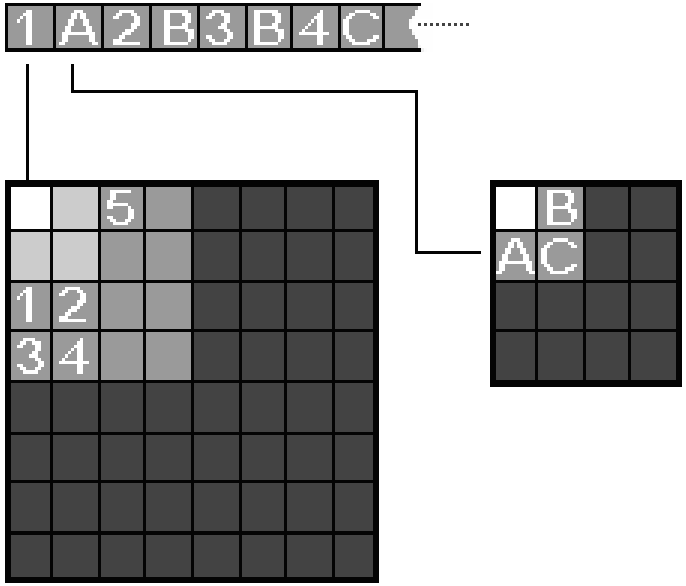
DC



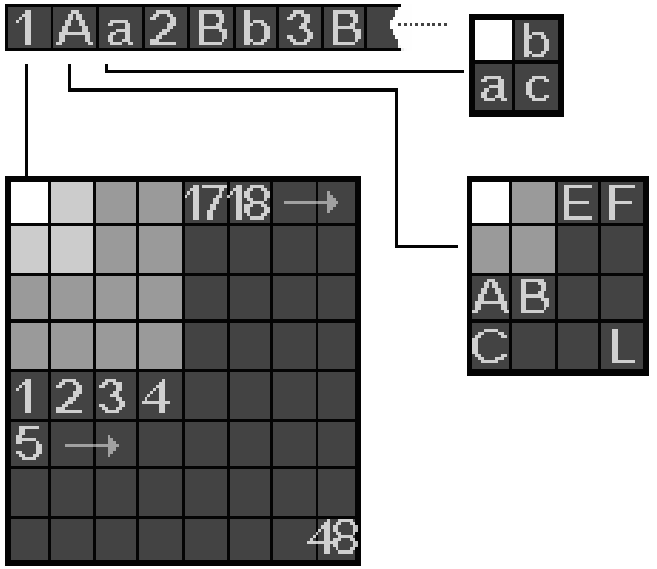
LEVEL3



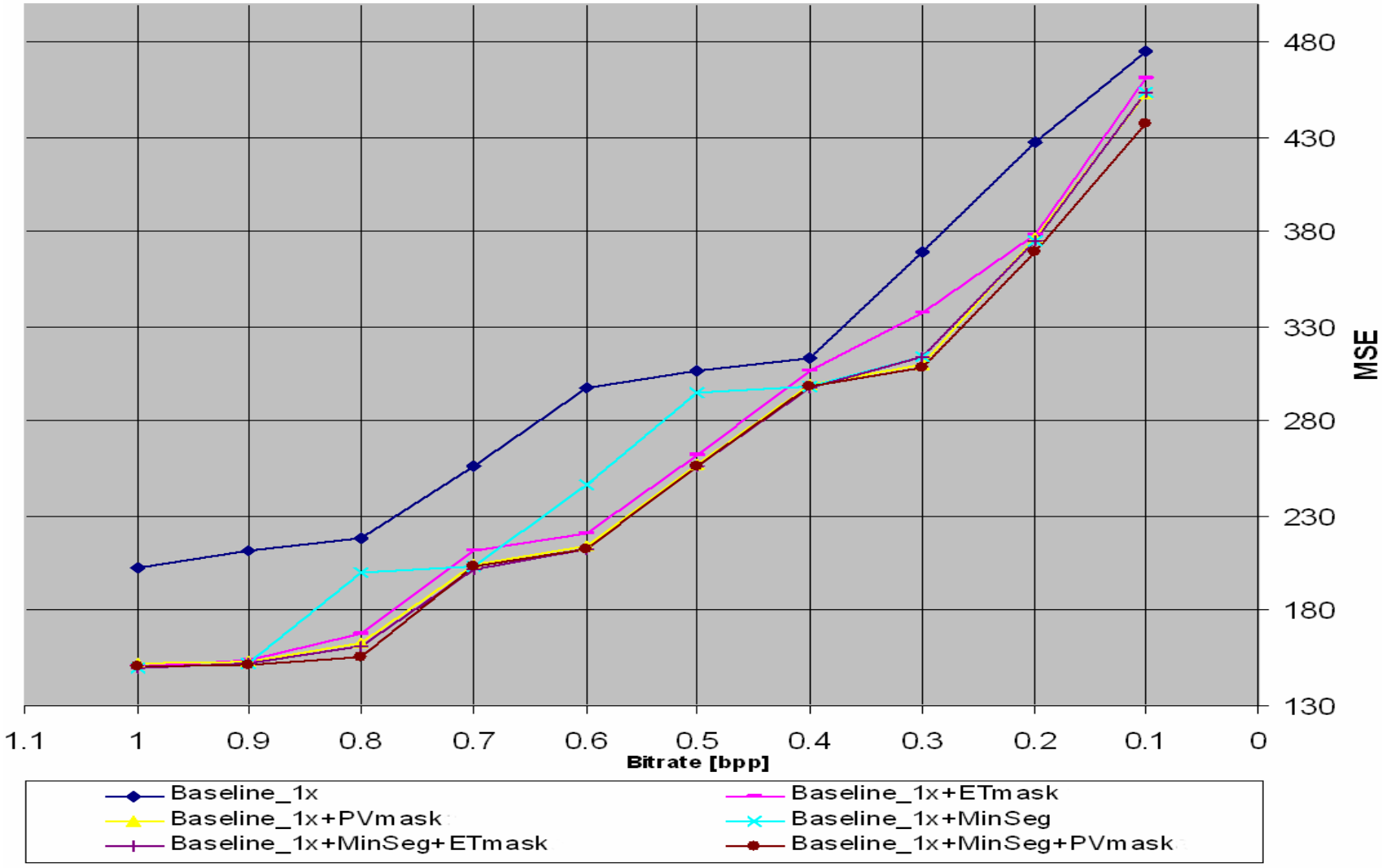
LEVEL2



LEVEL1

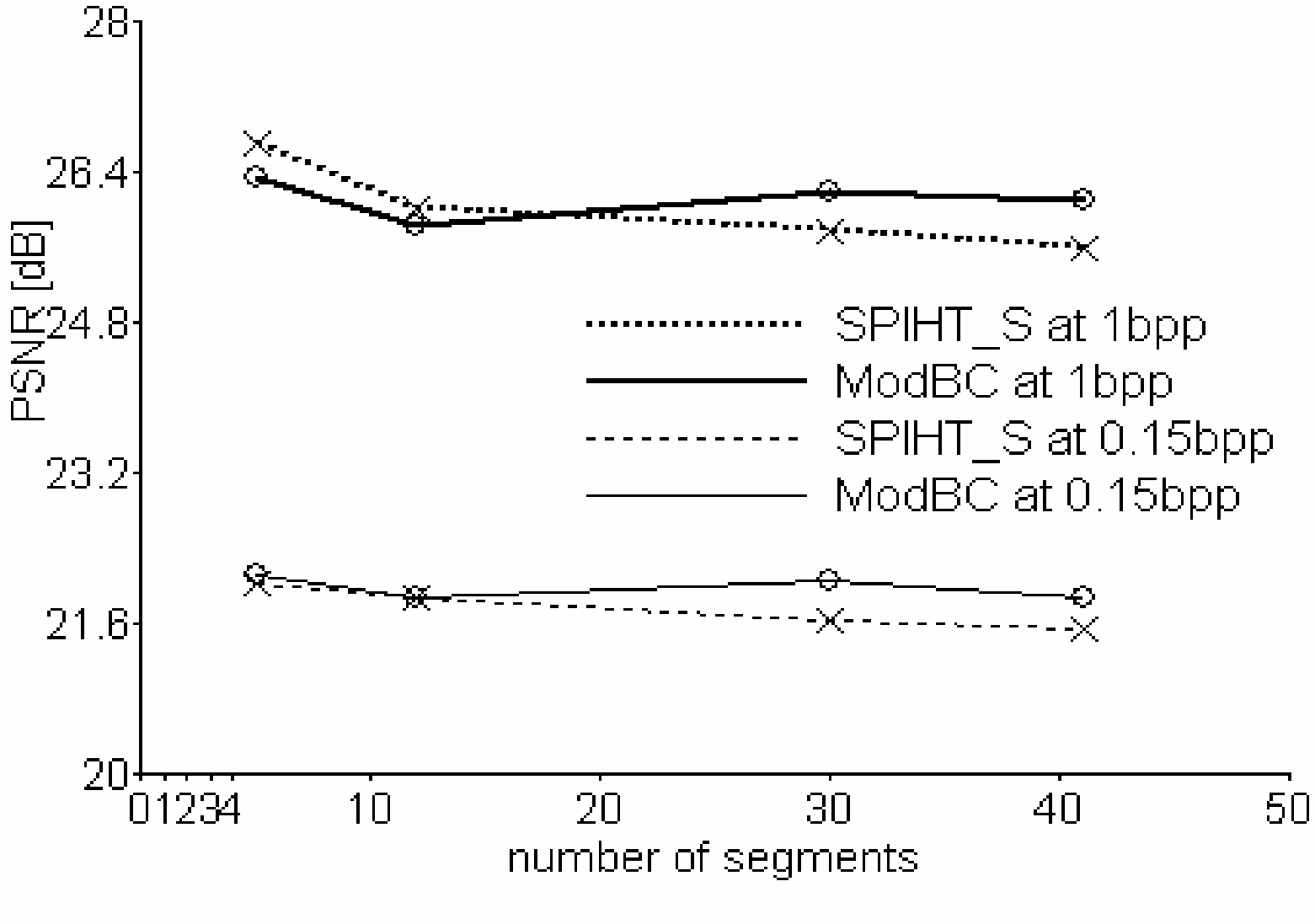


RESULTS

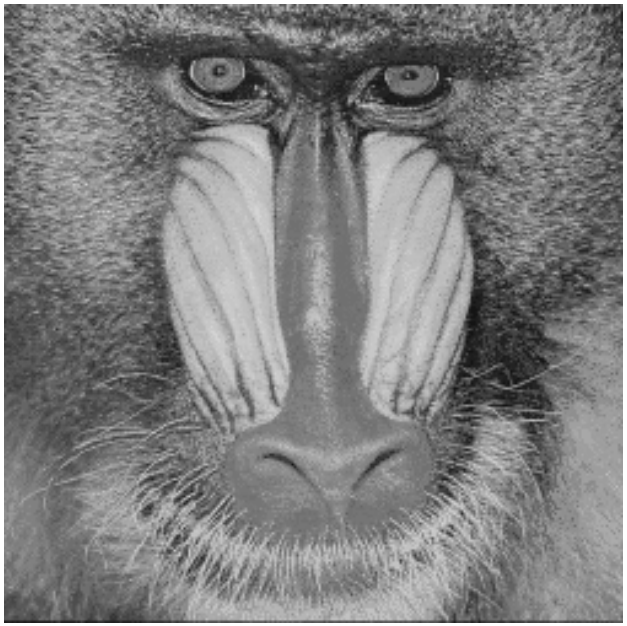


Influence of spectral mask choice and segment wrap around

Coding of segmented baboon Image using SPITH_S and ModBC.



Original



ModBC
with
5segments
at 0.15bpp,
PSNR=22.10

ModBC
with
41 segments
at 0.15bpp,
PSNR=21.87

BC
with no
segments
at 0.167bpp,
PSNR=22.45

Conclusion

- We adapted 2D DWT and BASELINE algorithm for segmented image handling

- Proposed method does not outperform the Baseline coder applied on non-segmented image in the sense of PSNR, but results of proposed method seem to be visually better in many cases.

- Proposed method gives better results as methods based on separate segment compression (especially when the number of segments grows)